TRAINING PROGRAMME ON SKILLS AND STRATEGIES OF TEACHING SCIENCE AT SECONDARY STAGE

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PREFACE

The success of any system of education depends on the quality of the teacher who holds the key to the effective translation of educational policies into concrete actions in the classroom and outside. Recognizing the role of the teacher in providing quality education, the Education Commission (1966) emphatically said *"Of all the different factors, which influence the quality of education and its contribution to national development, the quality, competence and character of teachers are undoubtedly the most significant"*. If teachers acquire real understanding of children and the subject(s) they teach and have rich school based experiences, they can progress well towards professionalizing the transaction of the curriculum resulting in realizing curricular as well as national goals. Naturally the nation therefore, expects from its teacher education system to earnestly address the gigantic task of preparing professionally competent and commitment oriented teachers.

A truly efficient programme of professional preparation of teachers must focus on developing mastery of instruction. In mastering instruction, emphasis should be placed on *what teachers do and what teaches think about what they do* In other words : (i) teachers should have cognitive learning in all the skills and strategies that they employ in order to think about their instructional performances and to cope with pressures and exigencies of teaching profession and (ii) that teachers are able to employ skills and strategies in order to help pupils in the vitally important process of learning

This document attempts to briefly focus on the need for education and training in skills and strategies in order to learn in the cognitive, affective and performance dimensions of learning the skills and strategies so as to become competent in skills and strategies The document also provides a conceptual framework for dovetailing

appropriate skills in a strategy for teaching the product (content) and processes (problem solving/inquiry) of curriculum.

The skills and strategies are explained highlighting the dimensional behaviours of teachers that enables them to learn the *'What'*, *'When'* and *'How'* of the skills and strategies This kind of presentation overcomes the limitation of emphasizing on the characteristic and purposes of the skills and strategies. Modelling and discriminant analysis are recognized as important techniques in developing cognitive learning of the skills and strategies. These techniques were used in conducting the programmes. Models of different skills are provided after the description of the skills to conceptualize the skills as well as component skills in action. It may be noted that the Models presented reflect the suggested conceptual framework The reader can appreciate that expository strategy provides an ideal context for integrating and practising the teaching skills (refer to strategy/ lesson plan for teaching of photosynthesis on pages 66 to 72). The model plans prepared for few skills by the participants are provided in Appendix - B, which may be used for discriminant analysis to identify appropriate and inappropriate use of skills/component skills to develop decision- making ability in teaching.

I hope you will find reading the contents of this document as enjoyable and rewarding as I found writing them. I also hope that the understanding gained from this would help to reform the practices followed in Institutions of Education for developing competence in skills and strategies of prospective teachers

Nirmala Y.

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(Nirmala Y)

Contents

SKILLS AND STRATEGIES OF TEACHING

1. SKILLS AND STRATEGIES OF TEACHING

A sound programme of teacher education has to take care of all the components of teacher education in a comprehensive and multi-dimensional manner. In-service teacher education refers to a recurrent, organised and need based continuing education of teachers already on the job to update and enrich their professional competencies, strengthen their commitment and enhance their professional performance in the classroom as well as in the school and the community. As new developments take place in school curricula, educational techniques, evaluation procedures, classroom management and other aspects of school education, new needs arise from time to time for in-service teacher orientation and hence it becomes recurrent in nature

The teacher preparation programmes have not changed much during the recent past and are therefore under severe criticism for being static, unresponsive to the emerging challenges of the present time. There is a growing feeling that teacher education is not effective in producing efficient teachers and this concern is adequately reflected in the National Policy on Education, 1986 and programme of Action, 1992.

In the present system of teacher education, the methods of teaching the content of school subjects in the teacher education curricula is inadequate and inappropriate. The methods of teaching school subjects have to be taught based on their content categorization and the use of appropriate techniques and strategies for teaching different kinds of content of school subjects The common content categorization in all the school subjects includes concepts generalizations, skills etc Selection of an appropriate technique and strategy depends on the nature of the content in general and type of

content in particular There is a need to use the appropriate techniques and strategies for teaching different kinds of subject matter.

The implication of existing situation is that pre-service and in-service teacher education programmes should develop the teachers' competence in strategies of teaching different kinds of subject matter and skills dealing with the process of interaction between teacher and pupils.

In pre-service teacher education programmes, the courses which have direct relevance for developing teaching competence are the content-cum-methodology courses and microteaching. The content-cum-methodology courses are compulsory, the microteaching is offered as a separate course or a component of a content-cum-methodology course. When these courses are offered as separate course, they are studied concurrently.

Teaching is generally considered as an integrated professional activity concerned with bringing about desirable changes in learners. It involves making decisions about when to use various teaching abilities and how to integrate these into the teaching act in order to provide conditions which facilitate learning. Therefore in the professional preparation of teachers, the emphasis should be on the development of self-concept and formation of appropriate cognitive structures, attitudes and professional skills in teaching. For, it is a combination of these factors which would eventually act as a major influence in shaping their attitudes and subsequent behaviours with regard to the decision-making process.

Microteaching is a valuable addition to repertoir of methods used in education and training of teachers There is extensive literature which documents the various practices that have been used in

order to cope up with such a complex situation, teachers require teaching strategies which would enable them to control the subject matter of instruction and direct student behaviour towards intended learning outcomes. In fact, several empirically based studies have led to the identification of two types of teaching strategies – content bound and content free (Smith, 1976) which are concerned with the ways of interacting with the content of instruction; interactions between teacher and pupils respectively. An added advantage of the teaching strategies from the point of training is that the teaching can be analyzed from the perspective of 'ventures' and 'moves' (content-bound strategies) or from the perspective of ensembles of specific skills, behaviours and activities (content-free strategies). These strategies can be an effective tool for observing, analyzing lessons and providing feedback to student teachers Thus there exists the need for training the prospective teachers in the use of teaching strategies.

The review of developmental work in microteaching reveals that learning in microteaching takes place in the cognitive, affective and performance skill dimensions of the teaching ability. The potential learning in microteaching points to the distinction between the performance, cognitive and affective dimensions of a teaching ability. However, the learning of a 'teaching skill' generally refers to its performance. For example, competence in explaining refers to making appropriate decisions about when to explain and giving fluent, lucid, interesting explanations. The performance skill dimension of the competence in explaining refers to presenting a fluent and clear explanation The cognitive processes include preparing rational explanations and recognizing suitable occasions to give explanation And the affective learning refers to valuing explaining and showing a desire to give effective explanations. Therefore, teacher education programmes need to take account of training in the performance skill dimension and education in the cognitive and affective dimension of

teaching ability These inferences form the rationale for the approach under consideration The approach has to be conceptualized in terms of the suggested inputs for each of the learning gains - cognitive processes, affective learning and performance skill of teaching skills and strategies

The social psychologist views teaching as a socially skilled activity dependent upon good inter-personal relationships and communication between the teacher and learners. Therefore, the nature of social skills of teaching - introduction, explaining, questioning, illustrating with examples, reinforcement, stimulus variation, achieving closure, classroom management etc., have to be explained on the basis of their contribution to implement the logical structure of the lesson.

The following strategies could be incorporated in pre-service and in-service teacher training programme, so that in schools student teachers and teachers can use them in their classroom teaching.

1. Concept formation and concept assimilation strategies

The teaching of concepts is different from other types of content. The different aspects of a concept viz., name of the concept, positive and negative examples for the concept, essential and non-essential attributes of the concept, value of the attribute and rule (definition) of the concept help in understanding the concept as well as in designing and implementing strategies for teaching the concept The concept formation and concept assimilation will take place based on the type and sequence of the aspects of a concept used.

2. Inquiry Strategy

Whenever we come across an unfamiliar object, event or a situation, our mind is stirred by questions which may help us in knowing more

about the object of our curiosity The process of 'finding out' or 'investigating' through questions, is essential in 'inquiry strategy' A model of inquiry training was developed by Richard Suchman to stimulate and direct the natural explorative instincts of children so that they can investigate new areas more forcefully in ways which help them to generate knowledge in a creative manner and organize it too.

3. Guided Discovery Strategy

The processes in guided discovery strategies help cognitive development of the learner

4. Integrative Strategy

Arriving at some general conclusion from discrete data is the process involved in an integrative strategy. This strategy helps to develop creative and meaningful ways of processing of information to build concepts and solve problems

5. Expository Strategy

The focus of this strategy is to enable students to participate actively in processing abstract idea presented to them to understand its meaning and implications and to establish relationship with ideas already learnt by them

6. Concept Mapping Strategy

Concept mapping strategy helps to build an organized knowledge base in a given discipline It promotes meaningful learning in science because it helps to relate new knowledge to relevant concepts they already know

7. Strategies for Teaching Social Issues

Resolving social issue is a basic problem for small groups and communities. This strategy is particularly effective in meeting the objectives, such as, analysis, reflecting on the concepts of justice and human dignity, acquiring democratic values etc

8. Strategies for Teaching Social Skills

The social skills can be developed by clarifying values and resolving conflicts. This strategy will help to promote the social values and skills

9. Group Based Instructional Strategies

The group based instructional strategies are important in the learning process The common group based learning strategies are . Role Play, Simulation, Games, Group Discussion, Debate, Quiz, Team Teaching, Tutorial, Project, Field Trips etc They play an important role in the attainment of instructional objectives.

10. Personalized Instructional Strategies

The personalized instructional strategies are very useful for self learning They are also known as auto instructional strategies. The common personalized instructional strategy includes Programmed Instruction, Computer Assisted Instruction, Self Paced Activity, Learning Activity Packages, Mini Courses, Modular Approach etc

In view of the importance of integrating teaching skills with teaching strategies for meaningful learning of science, *Skills and Strategies of Teaching Science at Secondary Stage* was proposed as a PAC programme

The programme was designed to help the teacher educators to

- Conceptualize the various teaching strategies
- Integrate teaching skills with teaching strategies to facilitate effective interaction between the teacher and the learner
- Develop exemplar instructional materials on skills and strategies of teaching science.
- Use exemplar instructional materials for developing teacher competence in teaching of science.

SKILLS OF TEACHING

SKILL OF INTRODUCING A LESSON

Generally very lesson is expected to begin with an introduction in which the teacher sets the stage for the subsequent instruction Teachers who are good at the skill of introducing found to use three different ways - The teacher focuses the student's attention on the topic of instruction This is often done simply by naming the topic In another way, the teacher states explicitly the goals or outcomes of subsequent study. A third way is one in which the teacher tries to convince students that the concept/ generalization/ skill to be learnt is useful to them for future learning or in daily life By stating the utility of the knowledge/skill to be acquired the teacher attempts to provide motivation to the learner Considering the importance of motivation in learning, the teacher is expected to use this move frequently. However Todd (1972) found that ten occurrences of motivation move in over fifty hours of classroom teaching This finding is in line with that of Cooney et al. (1975) who reported on the basis of review of research studies that teachers seldom employ motivation moves in teaching.

Runion (1972) developed seven ways by which the teacher could initiate and provide motivation These are.

1 Stating the goals of the lesson
2 Stating the major points to be covered in the development of the lesson
3 Using an analogous situation
4 Using historical information
5 Reviewing the perquisite knowledge
6 Giving reasons for studying a particular topic, and
7 Presenting a problem situation

Stating the goals of the lesson: The goals/objectives as statements, describing behaviours that the learners are expected to demonstrate at the end of instruction, provide learners some direction for study. Often motivation increases with the clarity of the objectives.

Example

While introducing the topic, *circular motion,* the teacher focuses on the goals of the topic as : Look at the wheels of a moving vehicle, blades of a fan in action or a pulley. The motion in all these instances which do not result in net displacement come under circular motion we will look into various aspects of circular motion to day

Stating the major points to be covered in the development of the lesson: In this approach the teacher outlines the major concepts/ generalizations/ skills to be covered in the development of the lesson. Like stating goals, this can be considered as providing the learner some direction.

Example

A physics teacher to start the lesson on *circular motion* may introduce the topic and highlight the major points as follows : Today we will discuss about the axis of rotation, plane of rotation, effect of mass and its distance from the axis and about circular velocity. Then we will try to explore various physical situations wherein we come across with circular motion.

Using an analogous situation: In this approach of using an analogue, he/she selects some object, process, or situation similar to one the students are to study. This approach is psychologically sound as it relates the unfamiliar to familiar The chemistry teacher might remind students of the balance and the operations that can be performed and still maintain a balance and then lead into the balancing of chemical equations in which he or she wants to emphasize performance of the same operations on both sides of the equations.

Using historical information: Using historical information is another way of introducing a topic. For example, before teaching the Archimedes principle, the teacher can tell the students something about who Archimedes was and what lead him to discover the principle In mathematics to introduce a lesson on quadratic equations reference may be made about the contributions of Sridharacharya. For teachers to be able to use this approach, they should be familiar with the history of the subject.

Example

In order to motivate students to learn the properties of methane gas, a chemistry teacher may use the following historical information

In olden days, miners all over the world faced dangers from a gas that filled the mines. The gas was ignited by the candles used by the miners for lighting. This led to fire and explosions causing several deaths. On analysis, the gas was identified as methane. Let us study more about this gas to day.

Reviewing the pre-requisite knowledge: Knowledge in a subject is highly structured. As a result learning a concept/generalization depends on a concept or concepts. By reviewing subordinate information, the teacher relates what is to be studied to what the students already know. The information reviewed is usually the prerequisite knowledge to understanding the knowledge to be taught later in the lesson If the teacher decides to use this approach, he or she should use by questioning to ascertain students' understanding of the prerequisite knowledge Thus the review can be diagnostic, with remedial teaching provided if and when it is deemed necessary.

Example

A chemistry teacher may elicit answers to the following questions from the students to ascertain whether students have the prerequisite knowledge to learn about *Types of Chemical Reactions.*

- What is a chemical reaction ?
- How do you symbolically represent a chemical reaction ?
- How do you balance a chemical equation ?

  Explain using the equation

  $Na + H_2O \longrightarrow NaOH + H_2\uparrow$

Giving reasons for studying a particular topic: A topic may be introduced by stating why the topic should be studied and how the same is useful to the students. This approach in combination with another approach - *a statement of goals* - is particularly effective in motivating as it makes clear to the students what they are to accomplish.

Example

When a lesson is to be taught on *'Lenses'* the teacher introduces the lesson and at the end of the introduction teacher may mention about how the study of this topic is useful for them in their future learning and its utility by saying that lenses are used in many optical instruments. And also mentions that the topic *'Lenses'* that we are going to discuss now has wider applications in film projectors, microscopes, binoculars, telescope etc.,

Presenting a problem situation: A lesson may gainfully be introduced through this approach to draw the students' attention or to arouse their interest in the topic to be studied By presenting a problem situation the teacher can make the students to realize that their existing knowledge is inadequate to find a solution to the problem or to provide an explanation for the observed phenomenon

Example

A chemistry teacher who is going to teach about *solubility of gases* may use the following situation to motivate the students to learn A bottle filled with a water soluble gas like HCl, NH_3 opened under a trough of water. Water rushes in and the bottle is filled with water.

(Teacher performs the experiment with ammonia before the students)

T . Why should this water rush in and almost fills the bottle ?

S6 . . . . . .

T . Teacher takes a corked bottle containing air and opens the cork under water in a glass trough. What do you observe ?

S : Water does not enter the bottle

T . Why is this contrasting situation/phenomenon ?

Instructional Plan for Skill of Introducing a Lesson

The following dialogue illustrates introduction of a lesson/topic using some of the ways described earlier.

1.T : In the previous classes you have studied about types of reproduction, with particular reference to the sexual reproduction. We define sexual reproduction as the fusion of male and female gametes. What is the product of this fusion?

2 S_1 : Zygote

3 T . Yes, What does the Zygote give rise to ? ..... .S_5 ?

4 S_5 · Zygote gives rise to an individual, because of its growth and development.

5. T . When the offsprings grow into adults, do they show any resemblance with the parents ?

6. S · Yes. The young ones resemble their parents in some respects.

7. T . Why do they resemble their parents ? Have you ever thought of how does a mango plant give rise to only mango plant not a neem plant ? How can a dog reproduce only dogs not cats ? Why does a tiger never give birth to a horse ?

8. T : There is a vast body of knowledge that deals with these and related problems. The development of the related knowledge is due to the work of Gregor Mendel, an Austrian monk. He carried out his scientific experiments on pea He was a very patient and keen observer and he carefully noted down the results of his experiments and formulated certain basic principles regarding the transfer of hereditary characters from parents to the offsprings However, the significance of his work was noticed much later in 1900, by three scientists namely Hugo Devries, Correns, Tschermak. His work has formed the basis of the study of heredity.

9 T : Today we will discuss these laws of heredity and try to know how the characteristics of parents are transferred to the offsprings through successive generations.

10.T · This body of knowledge that we are going to discuss has wider applications in plant breeding and animal husbandry. A lot of experiments have been carried out and are being carried out.

Let us analyse this dialogue. The teacher employed review of prerequisites in utterances 1 to 6, leading to presentation of problem situation by seeking an explanation for similarities between parents and their offsprings. The teacher probably knows from experience that students would not be able to provide an explanation to a phenomenon which they notice in nature. This arouses their interest in the topic to be discussed. The teacher further reinforced students curiosity by referring to (briefly/ implicitly) historical information related to Mendel's laws of heredity in utterance 8. Students attention is focused on the topic of the lesson in utterance 9. Finally in utterance 10, the teacher motivates students by stating the utility/importance of the knowledge to be learnt.

SKILL OF EXPLAINING

Teachers most commonly use expository (didactic/direct) teaching method to transmit knowledge In this method, the concept, generalization or rule to be learnt is stated early in the sequence and is followed by an explanation which seeks to clarify the meaning and implications of the item of knowledge The need for explanation becomes significant because the item of knowledge stated may not be readily comprehendable to all the students. As the goal of explaining, the act of presenting an explanation, is to provide understanding of an item of knowledge to the students, teachers should be competent in the skill of explaining.

Explaining is an act. Though explanations are to be used daily by all teachers in all subjects, it is a neglected area in teacher education The term 'explaining' is derived from the word 'explanare' which means to make plain According to Martin (1970) the process of explaining involves an explainer, the subject matter/knowledge to be explained and a set of explainees. The explainer has to take account of the kind of subject matter - concept/principle and of the prerequisite knowledge and skills of the explainees.

Thus, explaining is an attempt by the teacher to provide understanding of subject matter to the students The implication of this meaning is that explaining involves taking account of the subject matter in relation to a set of students. The teacher has to present or elicit from students a set of linked statements each of which is understood by the students and which together lead to understanding of the idea for that particular set of students. Therefore, for the teacher to be able to carry out the task of explaining, he/she must be able to analyse the implicit questions in the idea to be explained.

Types of Explanation

There are three types of explanations namely, the interpretive, the descriptive and the reason giving. They are also sometimes called as ***What***, ***How*** and ***Why*** explanations respectively as the explanations are used to answer the what, how and why types of questions.

1. Interpretive Explanation

An interpretive explanation is an explanation that clarifies the meaning of the concept, generalization or rule. Though the main purpose of interpretive explanation is to make the central idea clear to the students, the nature and scope of interpretation varies within and between the kinds of knowledge-concept, generalization and rule. That, the way concepts are interpreted is different from that of a generalization. Also the way mathematical generalizations are interpreted is also different from that of generalizations in other subjects. The following are some of the ways of interpreting knowledge:

a) Paraphrasing the item of knowledge

The teacher may clarify the meaning of the concept or generalization or rule by restating it in different words, presumably easier to understand. The teacher may also state the definition in the conditional form (as a necessary/sufficient or necessary and sufficient condition).

A Chemistry teacher, who stated Boyle's Law that pressure of a gas is inversely proportional to its volume at constant temperature may paraphrase the law as pressure of a gas decreases with increase in volume and it increases with decrease in volume at constant temperature.

Teachers often paraphrase (translate) in verbal form a generalisation stated initially in mathematical language or vice-versa For example, the Boyle's law having been stated in verbal form, the teacher may state it in mathematical language as.

If P and V are pressure and volume of a gas at a particular temperature, then

$$P \propto \frac{1}{V}$$

Biology teacher who defines photosynthesis as *an anabolic process of preparing food by plants in the presence of sunlight and chlorophyll* may paraphrase the definition as *photosynthesis is the process by which plants prepare complex organic food materials from simple inorganic materials (like CO_2 and water) in the presence of sunlight and with the help of chlorophyll.*

Teachers often translate the verbal form of a definition in symbolic form or vice versa.

e.g. The definition of photosynthesis can be written as

$$6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

b) ***Reviewing the prerequisite concepts***

If a teacher decides that the source of difficulty in comprehending the knowledge that is asserted initially is lack of knowledge of a term(s) used in the statement, he/she may recall or elicit the meaning of the term(s) with a view to clarify the asserted knowledge.

For example, in the definition of photosynthesis the teacher may review the meaning of *Anabolism* as the *process of synthesizing complex organic food materials from simple inorganic materials*

c) ***Giving Examples/instances***

Teachers frequently give one or more examples of a concept to clarify the concept This is because examples are definite, specific and if properly selected, familiar. They possess all the characteristics of a concept which are mentioned implicitly or explicitly in the definition of the concept When an example is presented and is followed by a reason, the reason is the statement which explicitly clarifies the essential characteristics of the concept Similarly, the teacher may also clarify a concept by presenting a non-example with a reason. The reason that follows a non-example is a statement to clarify the absence of an essential characteristic of the concept. By using this, the teacher makes it clear that for an object to be an example, it should have the essential characteristic

In case of a generalization, the teacher uses one or more instances of a generalization, the teacher uses one or more instances of a generalization. It may be noted that an instance is always a sentence whereas an example is an object. A difference between an example and an instance is that an example is used to refer to the denotation of concepts and an instance is used to refer to immediate implications (applications) of generalizations

While teaching the concept *complex tissue* the teacher shows labeled diagrams of tissues drawn on the rolling board and asks the children to name among them the complex tissues If children respond by saying xylem and phloem are complex tissues, then teacher elicits the reason why xylem and phloem are complex tissues Similarly, the

teacher may show the *cortex* part of the diagram and ask whether it is a *complex tissue* When the response from the children is *No,* then the teacher may elicit the reason for cortex to be a non-example of complex tissue. Thus the concept of *complex tissue* is clarified by presenting examples and non-examples with reason

2. Descriptive Explanation

Descriptive explanation is an explanation of a process, structure, or procedure. This type of explanation is needed when a sequence of steps/ procedures leading to a product or completion of a task; functioning of a system/ organization, a chronological event, the arrangements of parts in a whole, inter-relationships among the elements of a system are to be clarified. For instance, questions such as *How can angle bisector be constructed ?, How do streams become polluted ?, How does the internal-combustion engine work ?, How did colonial rule lead to the Vietnamese war ?, How does a plant cell differ from an animal cell ?.*

In teaching students how to do something, a teacher may state a set of prescriptive principles and then do overt activities as designated by the prescriptions, which we shall call as demonstration. By demonstrating, or prescription, the teacher clarifies the procedure designated by the prescription by providing students a model of behaviour they can imitate.

In the same way a science teacher can demonstrate the preparation of oxygen in a laboratory.

The science teacher can demonstrate the release of oxygen gas during photosynthesis by showing/doing an experiment or narrate the mode of locomotion in hydra by using descriptive explanation.

In providing a descriptive explanation, the teacher can also make use of a learning aid – chart, model - working or static.

3. Reason Giving Explanation

A reason giving explanation is an explanation which offers reasons or arguments and show that the stated generalization is true or that the occurrence of a phenomenon or use of a rule/procedure has a basis. Giving reasons/proof becomes appropriate when there is uncertainty or doubt about the truth value of a generalisation. In order to remove uncertainty or doubt, teachers provide/elicit a set of statements to show that the generalization follows from those statements and hence the generalization is true.

In science, teachers experimentally verify a law of nature.

Examples for Interpretive Explanation

Subject: Chemistry Concept: Oxidation

T · Oxidation is a chemical reaction involving loss of electrons.

When zinc reacts with copper sulphate solution, zinc sulphate and copper are formed

$Zn + CuSo_4 \longrightarrow ZnSo_4 + Cu\uparrow$

This reaction is an oxidation reaction because zinc loses electrons to form zinc ions.

$Zn \longrightarrow Zn^{++} + 2e$

Copper ions in copper sulphate solution gain these electrons

forming metallic copper.

$CuSo_4 \longrightarrow Cu$

T . Sodium reacts with chlorine thus forming sodium chloride

Is it an oxidation reaction ?

S · In this reaction, sodium ion is formed by loss of electron from sodium $Na \longrightarrow Na^+ + e$ This is an oxidation process.

Chlorine ion is formed by gain of electron by chlorine.

$Cl_2 + 2e \longrightarrow 2\ Cl$

This is not an oxidation process.

A chemical reaction is not an oxidation reaction, if there is no loss of electron/s.

When sodium chloride solution is added to silver nitrate solution, a white precipitate of silver chloride and soluble sodium nitrate are formed.

$NaCl + AgNo_3 \longrightarrow AgCl\downarrow + NaNo_3$

In this reaction, sodium ions, chloride ions, sliver ions and nitrate ions are present before and after the reaction Since there is no loss of election (s), this is not an example of oxidation reaction.

Subject: Biology **Concept : Simple leaf**

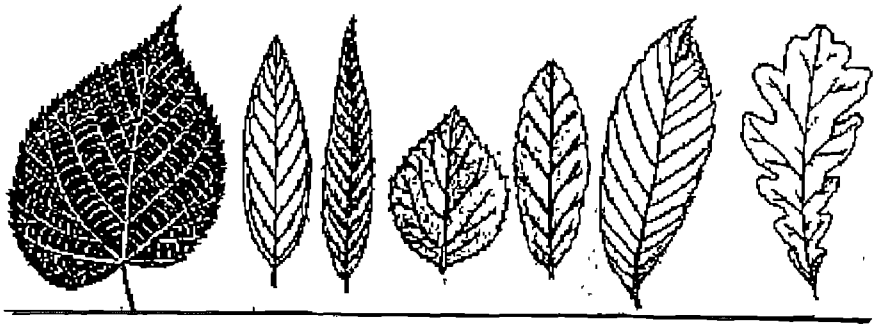
Students have learnt about the structure of a leaf

T What is a leaf ?

S Leaf is a green flattened lateral appendage of the stem or branch that arises from the node

T That is right. Teacher shows the diagrams of some leaves What difference do you find in these leaves ?

Fig. A



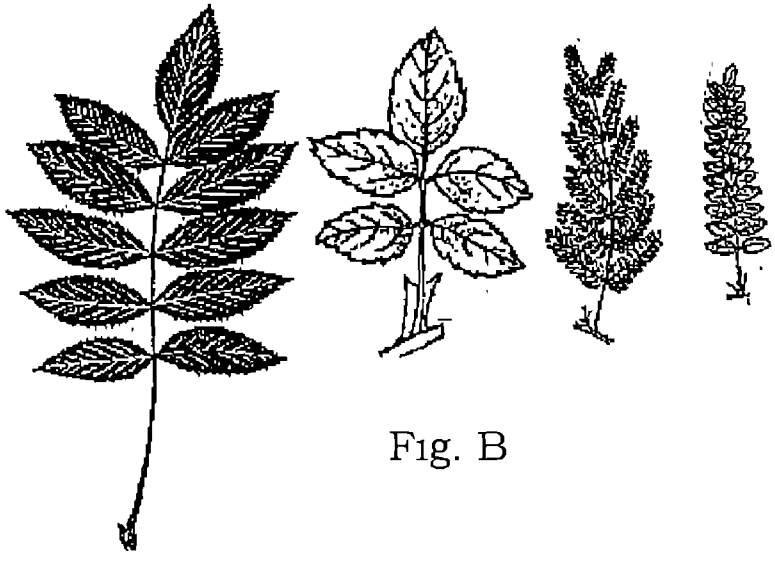


Fig. B

S In Fig A the leaves have only one leaf blade (lamina) and in Fig B the leaves have more than two leaf blades

T : Yes. In Fig.A the leaves have only one leaf blade. Where as the leaves in Fig B have more leaf blades. So if a leaf has one leaf blade or lamina, it is called simple leaf. Now say what is simple leaf ----- S_8?

S_8 Simple leaf is a leaf which consists of a single leaf blade (lamina).

T : Good Name a plant which has simple leaves

S : Hibiscus.

T : Good. We find simple leaves in Hibiscus plant (and shows the leaves of Hibiscus). Now observe the leaves of Hibiscus and tell me how is the margin of the leaf ?

S . Leaf margin is not smooth.

T : Yes. The leaf margin is not smooth. That means the margin is not entire, it has some incisions.

In some simple leaves the incisions may be more deeper towards the midrib but the incisions will not reach till the base of the midrib or petiole (Teacher tells the students to observe this in the last leaf in Fig.A)

Now define simple leaf. . . . . .S_6

S_6 A leaf is said to be simple when it possesses single leaf blade and having incisions extending from margin towards midrib.

T . Is that right ? . .. . S_{18} you define

S_{18} Yes. Simple leaf is a leaf which consists of single leaf blade and possessing incisions extending from margin

towards midrib but not reaching till the base of the midrib or petiole

T Good. Now teacher shows the leaves of rose plant. What kind of leaf is this ?

S . . ..

T : How many leaf like structures are seen in this ?

S Five

T Yes Where are these five present ?

S They are present above the petiole.

T Do we consider each of these as a leaf ?

S No

T : Why ?

S They are not separate leaves because they are not arising from the nodes of the stem

T Good. We have studied that leaf arises from the node of the stem or branch. Here all the five leaf like structures are attached to the node with the help of a single petiole. So here the lamina is divided into five independent parts which are called leaflets.

Do you call this type of leaf as simple leaf ?

S No

T Why ?

S It is not a simple leaf because it has more than one/two leaf blades But simple leaf should have only one leaf

leaf blade.. But simple leaf should have only one leaf blade. So it is not a simple leaf

T : Now name some other plants which have simple leaves

S_7 . Ficus, Guava

S_{15} : Banana

T . Very Good. Each of you collect few leaves from your home and try to identify which plants have simple leaves and draw the diagrams of those leaves and bring when you come for the next class.

Example for Descriptive Explanation

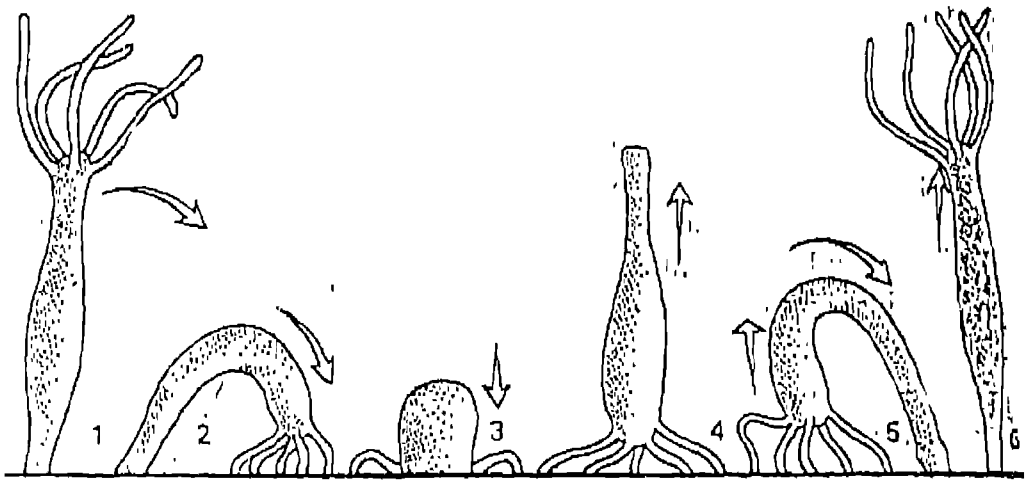
[After relevant introduction to motivate the students to learn the topic ***Locomotion in Hydra*** the teacher describes somersault movement.]

We have learnt that hydras are usually sessile animals. That is, they are animals which live attached to objects. Usually hydras live attached by their pedal or basal discs to objects in water But sometimes they show movement to change their location either in response to light or some chemical stimulus or to get food. There are different types of movements in hydra Let us learn one type called somersault movement.

Somersault movement is a type of movement in which hydra moves by bending its body in any direction like an acrobat and in that process it reaches from one place to another.

Teacher shows a chart having different stages in the movement of hydra and describes as follows.

See the figures of hydra in the chart.



A Somersaulting in Hydra B

In the first figure, hydra is seen erect and attached to a substratum with its basal disc. Now in the second, you can see that its body and tentacles have become very short. Here the tentacular end is brought forward and attached to the substratum. Then the basal disc is freed and moved upwards (pointing to figures-3 and 4) thus enabling the hydra to assume an inverted posture. Then the basal/pedal disc is moved forward and attached to the substratum to a new position as in figure-5 Now as seen in the sixth figure, the hydra frees the tentacular end and again assumes its upright position. In this way hydra moved from position A to position B by performing one somersault. Thus hydra moves from one place to another place by a series of somersaults like an acrobat. In this diagram, hydra's movement is from left to right (forward movement). Hydra can also move from right to left (backward) by a series of somersaults.

SKILL OF QUESTIONING

Questioning is one among the most frequently observed behaviours of a classroom teacher Since it can be assessed on the criteria of proficiency and effectiveness, it is viewed as a skill of teaching. Questioning is employed during a class for several instructional purposes. It may be used to stimulate thinking, assess student progress, check on teacher clarity, motivate students to pay attention, maintain classroom control, provide repetition, emphasizes key points etc

Acquiring the skills in questioning is an important step towards becoming an effective teacher. A good questioning technique can

- *allow teachers to gather information about the level of students' knowledge*
- *actively involve all students in learning*
- *develop the communication skills and confidence of students,*
- *encourage students to become self-directed learners and*
- *provide recognition and reward for achievement.*

The skill of questioning consists of the following sub-skills

- *Structuring of questions*
- *Delivery of questions*
- *Distribution of questions*
- *Probing questioning*

Apart from the above sub-skills it is possible to assess a question based on the level of thinking involved in answering it. When teachers use questioning skillfully they engage their students in an exploration of content. Carefully framed questions enable students to reflect on their understanding and consider new possibilities.

Classroom questions can also be analysed in terms of the level of thinking required for answering it The level at which a question is asked can be analysed by employing Bloom's taxonomy of knowledge, comprehension, Application, Analysis, Synthesis and Evaluation. Most questions that teachers ask are simple recall questions that require the student to remember some factual information and recite it to the teacher. Such questions are called knowledge level questions. Knowledge represents the lowest level of thinking practice and only requires bringing to mind the required fact or material. Comprehension level questions require a student to interpret prior learning by asking the student to describe, interpret, explain, illustrate, paraphrase or restate. The application level questions require a student to transfer information he has learnt to a life problem or a new task with a minimum of direction.

At the analysis level, a student needs to demonstrate an ability to examine, take part, predict and draw conclusions Whereas, at the synthesis level he is required to originate, combine and integrate parts of prior knowledge into a product, plan or proposal that is new. Evaluation level is the highest level of cognitive functioning according to Bloom. It is the ability to judge the value of material for a given purpose. The judgments are based on some definite criteria that the student can define and state. The criteria might be an organization or pattern of the facts or a determination based on relevance to purpose This level contains elements of all previous levels and conscious value judgements.

Structuring of Questions

Though the structuring of question happens in the mind of the teacher, it is possible to assess the appropriateness of the structure of a question once it is delivered.

The guidelines for structuring of classroom questions are related to the format of questions to be structured. The guidelines are suggestive not prescriptive. They are avoiding (a) questions requiring *Yes* or *No* responses (b) leading questions (c) double barrelled questions (d) ambiguous questions.

(a) Questions requiring 'Yes' or 'No' Response: When the question starts with auxiliary verbs, the response will be '*Yes*' or '*No*'. This type of question do not stimulate thinking in pupils and have scope for guessing.

Examples

	Poorly structured	***Well structured***
i)	*Is there any effect of light on plant growth ?*	*What is the effect of light on plant growth ?*
ii)	*Is it necessary to supplement the soil with fertilizers and manures for proper growth of plants*	*Why is the soil supplemented with fertilizers and manures ?* *Or* *What is the reason for adding fertilizers and manures to the soil ?*

(b) Leading questions: This type of questions also expects the response in '*Yes*' or '*No*' form The expected response is hidden in the question itself. Such questions make pupils lethargic and they require no thinking.

Examples

	Poorly structured	***Well structured***
i)	*Vascular plants are evolved from non-vascular plants Isn't it ?*	i. *How are vascular plants evolved ?*
ii	*Darwin postulated the theory of 'Natural Selection' Did he?*	ii *Who postulated the theory of 'Natural Selection' ?*

(c) Double-barrelled questions : This type of questions consist of two or more ideas which are to be considered at the same time. Such questions make the pupils to forget some of the important aspects of the question. Hence it can be broken down into two or more simple questions each covering one idea at a time.

Examples

	Poorly structured	***Well structured***
i)	*What are the different cell types of phloem ? What are the functions of phloem ?*	1 *What are the different cell types of phloem ?*
		2 *What are the functions of phloem ?*
ii)	*What is meant by autogamy? and how does it differ from allogamy?*	*What is meant by autogamy ?* *How does autogamy differ from allogamy?*

(d) Ambiguous questions : They include elliptical questions. That is they are vague and fails to communicate properly the

intention of asking a question.

Examples

		Poorly structured	***Well structured***
(d)	i)	*What about respiration ?*	*What do you mean by respiration ? or* *Define respiration*
	ii)	*What about the leaves of a plant?*	*What is the structure of a leaf ?* *or* *What are the different parts of a leaf ?*

Components of Skill of Structuring Questions

Skill of structuring classroom questions involves framing of as many meaningful questions as possible to teach the given topic effectively. A question becomes meaningful when it is well structured. That is if it is relevant, precise, clear and grammatically correct. Hence the components of skill of structuring classroom questions include

- *Relevance*
- *Precision*
- *Clarity*
- *Grammatical Correction.*

Relevance : It means the suitability of the question to the specific instructional objectives of the lesson and the content being covered.

An irrelevant question in the class is that which is not related to the lesson on hand and it breaks/hinders the continuity of the lesson and diverts pupils' attention and creates confusion in the class.

Precision : It refers to the length of the question A question is said to be precise when it does not have redundant/extra words Questions should be direct and straight forward

i *Who can tell me what is respiration ?*

ii. *Does any one know who invented bullet proof Jacket ?*

In these questions extra, unnecessary words are used such as *'who can tell me'* and *'does any one know'*. These should be avoided to make the question precise and straight forward.

Clarity : It refers to the understandability of the language of the questions. Question should not contain words which are not clear to the pupils. They fail to *'arouse curiosity'*, *'catch attention'* and *'stimulate thinking'*

eg . What is the flora and fauna of your locality ?

Correct form . What are the plants and animals found in your locality ?

Grammatical Correctness : Teachers should use grammatically correct language while framing questions. Grammatically incorrect questions create confusion in the minds of the pupils

eg : How does ascent of sap takes place in plants ?

Correct form . How does ascent of sap take place in plants ?

Delivery of Classroom Questions

Teachers ask questions while teaching mainly for proper verbal communication to arouse curiosity and stimulate thinking The effectiveness of teacher's questioning depends mainly on its delivery. Delivery of a question includes (i) the speed with which the question is posed, (ii) the voice – its tone and pitch and (iii) the pause - small periods of silence given to allow them to think. So the components of skill of delivery of classroom questions include

- *Speed*
- *Voice*
- *Pause*

Speed : It refers to the time taken in delivering the question to the pupils. It should be in accordance with the pupils comprehensibility Lower order questions can be asked faster than the higher order questions. Speed depends on the cognitive development of pupils and the level of thinking required to respond.

Voice : It refers to the audibility and modulation Intonation specific words or phrases of a question emphasizes the specific object that are to be considered in the question.

Pause : It refers to the small periods of silence shown by the teacher immediately after delivering the question It is important in determining the kind and level of thinking stimulated in pupils Short pause is required for lower order questions and long pause is required for higher order questions

Distribution of Classroom Questions

Distribution of classroom questions refers to (i) space (ii) distribution among volunteers and non-volunteers and (iii) redirecting the same question again among volunteers and non-volunteers.

Questions should be distributed equally in the classroom based on the seating arrangement and among volunteers and non-volunteers to involve the whole class to make teaching effective and to increase pupils' participation Redirection is necessary to check the passive listeners and to secure and maintain pupils' attention in the classroom.

Probing Questioning

The purpose of asking questions is to elicit responses from the pupils. When a question is posed in the class, it is followed by a variety of responses from pupils. These responses range from *No Response* to completely *correct response* depending on the nature of the question and the pupils' level of thinking. The teacher has to take the responsibility to deal with such responses in a manner to elicit criterion responses from pupils. The various response situations that usually teachers come across with are

- *No response*
- *Wrong response*
- *Partially correct response*
- *Incomplete response*
- *Correct response*

These responses need to be dealt with in such a way that the teacher is able to seek *criterion responses* from the pupils This can be done by leading the pupils to correct responses. The sets of teacher behaviours desired to this objective comprise, the skill of '*Probing Questioning*' .

The skill of *Probing Questioning* involves going deep into the pupils response by asking a series of subsequent questions to elicit the criterion response. The components of skill of probing questioning are

- *Prompting*
- *Seeking further information*
- *Refocusing*
- *Increasing critical awareness.*

The purpose of using these components are to (i) lead the pupil from a *No response* or *wrong response* to the *criterion response* (ii) clarify pupils understanding about the response (iii) involve all pupils in the learning process (iv) increase their critical awareness.

Prompting : It involves the teacher to provide hints/cues which help the pupils to arrive at correct response. It leads the pupils from *No-response* or *wrong response* situation to the *correct response* situation. While using prompting teacher guides the pupils to respond by himself/herself by providing hints carefully but not by supplying the answer.

Seeking further information : If the initial response of the pupil is either *incomplete* or *partially correct*, then the teacher helps the pupil to clarity, elaborate or explain his/her initial response. By doing this the teacher tries to seek additional information to bring the initial response to the expected response level. If the pupil's answer is based on guessing, he/she will not be able to give the reason or clarify the

answer in his/her own words.

Refocusing : It is used when there is correct response by pupil To strengthen the response given by the pupil, the teacher refocuses pupil's response and wants the pupil to relate it with something already learnt in the class or requires the pupil to consider the implications of the given response in more complex and novel situations. It also stimulates thinking in the pupils

Increasing Critical Awareness : It is also used when there is correct response. It involves asking '*how*' and '*why*' of a completely correct response. The purpose is to seek critical awareness in pupils. The teacher asks pupils to justify the response rationally.

The following dialogue illustrates the use of component skills of *probing questioning.*

Instructional Plan for Skill of Probing Questioning

1 T : Sometimes we find new species of plants growing in a place where there is no parent plant of that species. How does it happen ?

2 S_3 : Seeds from other places fall, germinate and grow.

3 T : How do the seeds come from other places ?

4 S_7 . They are carried away by different means/methods from place to place

5 T : Name any method by which seeds scatter or carried to other places ?

6 S_{10} : .. ..

7 T : What is done with the seeds after eating mango fruits ?

8 S_{15} . The seeds are thrown away

9 T : Good. Here who facilitated the dispersal of seeds ?

10 S_1 : Human beings.

11 T . Yes, Here human beings are the agents of dispersal of mango seeds. Likewise, name some other agents which facilitate seed dispersal ?

12 S_4 · Wind, water, birds and animals.

13. T · Good What type of seeds are carried by the agent – say, wind ?

14S_{12} . The seeds which are lighter

15 T . Apart from this characteristic (being lighter), what are the other characteristics you find in the seeds for facilitating wind dispersal ?

16S_{17} : Some seeds have hair-like structures and some have wings.

17 T : Right. What adaptations you can think of in the seeds which are dispersed by water ?

18S_2 : ... .

19 T : Suppose a coconut fruit has fallen in a stream/river, what would happen to it ?

20S_2 · It will be carried away by water

21T : What are the modifications/adaptations for the purpose of their dispersal ? (Student gives the answer)

22 T . Very good So the method of dispersal depends on the structure of the seeds. What would happen if the dispersal

of seeds does not take place ? . . . S_{19} ?

23S_{19} . If the seeds are not dispersed, all of them germinate at the same place and grow.

24T . Yes. What would happen if all the seedlings grow at the same place ? ..... S_{22} ?

25S_{22} . They do not get required nourishment and so they may die.

26T · Good Therefore, dispersal of seeds is necessary for proper propagation of plants.

Let us see how are these component skills used while teaching the topic 'Dispersal of seeds'. From 1-3 utterances the teacher tried to 'seek more additional information' when the response is partially correct in order to bring the initial response to the expected response level. In utterance 5, when there is correct response, teacher tried to 'refocus' it and expected the pupil to relate it with something they experience/observe frequently. In utterance 7, teacher has provided some cue/hint/prompt to bring the 'no response' to the 'correct' level. Similarly in the subsequent steps these component skills are used repeatedly to handle the various response situations while teaching the lesson.

SKILL OF STIMULUS VARIATION

Learning depends on the students' interest and attention in the class. It is the responsibility of the teacher to secure and sustain students' attention for making the teaching effective. Students feel disinterested if the teacher continuously use the same stimulus or activity for a long time in the class, because it restricts their postural mobility and it causes monotony which results dullness in the class. To overcome this in the classroom and to secure and sustain their attention, teacher has to include the element of variation in teaching. This variation can be introduced in many different ways The variation may be in teacher's movement, voice or interaction with the pupils etc. So the skill of *stimulus variation* can be defined as the set of teacher behaviours that tend to secure and sustain pupils' attention in teaching learning situation through varied stimuli.

The components of the skill are

- *Movement*
- *Gestures*
- *Change in voice*
- *Focussing*
- *Change in interaction pattern*
- *Pause*
- *Pupil participation*
- *Aural - visual switching*

Movement : The movement of the teacher in the classroom helps pupils to change their postures and also gives physical relaxation to

them and it creates alertness and enthusiasm and variety in the teaching behaviour But the teacher movements should be meaningful. Carefully planned meaningful movements only are likely to secure the attention of the pupils Habitual movements which are a kind of mannerism behaviour of the teacher fail to attract their attention.

Gesture : Gestures are non-verbal cues to express feelings and emotions to emphasize significant ideas, to indicate shape, size and movement of objects etc. They usually consist of hand and head movements, eye movements and facial expressions etc. They enhance the verbal communication. Gestures should be appropriate to the nature of the idea being explained, then only they are meaningful.

Change in Voice : The voice has several dimensions like pitch, tone and speed. Constant use of the same level of pitch, tone and speed by the teacher makes the communication dull. A skillful teacher varies the voice to make teaching more interesting and to secure the attention of pupils. eg : Sudden change in tone and pitch of teacher voice immediately catch pupil attention.

Focusing : It can be of three types - verbal, gestural and verbal-cum-gestural focusing. Through focusing also teacher can secure the attention of pupils in the class.

Change in interaction pattern : The communication that goes on between the teacher and pupils is called interaction The interaction may be verbal or non-verbal In the classroom the interaction may be of three types - (i) teacher-group interaction (ii) teacher-pupil interaction and (iii) pupil-pupil interaction. The shift from one pattern of interaction in the classroom to another increases the interest of pupils and thus sustains the attention of pupils throughout the class.

Pausing : Pausing refers to the small periods of silence during teacher's talk. If it is used properly, it helps in securing and maintaining pupil attention A short pause is effective. If the pause is too long it loses its effectiveness to secure pupil attention.

Pupil Participation : Pupils like if they get an opportunity to participate in the class Teacher can make the pupils participate for handling apparatus during demonstration, dramatisation, or for writing on the blackboard etc. It holds their interest and attention.

Aural-Visual Switching : When the teacher uses aural or visual medium, it should not be used continuously for a long period. Teacher should vary the medium through which he/she interacts with pupils i.e , from aural to visual or aural to aural-visual or visual to aural etc.

SKILL OF REINFORCEMENT

All the pupils need social approval of their behaviours When pupils are answering or responding in the class, they are anxious to know whether or not their answers or responses are correct. In such situations the pupils feel happy and get encouraged if they are appreciated for their correct answers It also increases their participation in the classroom. In psychology of learning, the concept of reinforcement indicates that an individual tends to repeat the pleasant experiences and avoid the unpleasant ones. Therefore it constitutes one of the essential conditions of learning

Positive reinforcers are stimuli that provide or contribute to the pleasant experiences, while negative reinforcers are the stimuli that provide unpleasant experiences. Positive reinforcers are used for strengthening the desirable pupil responses and negative reinforcers are used for weakening the undesirable pupil responses. So the skill of reinforcement refers to the effective use of reinforcers to modify pupils' behaviour in the desired direction Reinforcers can be used verbally or nonverbally. Based on this they are categorised as

- Positive verbal reinforcers
    - *used in the form of praise words like good, yes, right excellent etc.*
- Positive non-verbal reinforcers
    - *used in the form of gestures expressing pleasant feelings like smile, nod etc*

- Negative verbal reinforcers

    - *used in the form of discouraging words like no, incorrect, wrong etc.*

- Negative non-verbal reinforcers

    - *used in the form of gestures conveying unpleasant feelings like frowning, shaking head etc.*

- Extra verbal reinforcers

    - *used which are neither verbal nor non-verbal such as hm-hm, uh-uh, Aaah, Um-Um etc.,*

Absence of positive reinforcers for pupils desirable behaviours may lead to loss their confidence which in turn may lead to poor self-image. Positive reinforcement encourages pupils to participate actively in classroom interaction. It stimulates them to learn more and thus creating a sense of accomplishment.

SKILL OF USING BLACK BOARD

Blackboard is the visual device most widely used by the teacher for classroom instruction. The skillful use of blackboard is important for the following reasons.

- A good blackboard work brings about clarity in the understanding of the concepts being taught through clear visual presentation.

- If the blackboard is used throughout the class for developing the lesson, a good work on it gives a wholistic picture of the lesson.

- If the blackboard is used skillfully, it adds variety to the lesson and draws attention and interest of the pupils.

The components of the skill of using Blackboard are

- *Legibility of handwriting.*

- *Neatness in the blackboard work.*

- *Appropriateness of written work on the blackboard.*

1. **Legibility of Handwriting** : The handwriting is said to be legible when there is maximum ease in reading it. To make the handwriting move legible, the points to be followed are :

   - Every letter should be distinct.

   - Adequate spacing should be there between two letters, two words and between two lines.

- The slantness of each letter should be close to the vertical.

- The size of the letters should be large enough to be read from the far end of the room.

- The size of the capital letters should be just bigger than the small letters and should not be so big as to form an obstacle in reading.

- All the capital letters and small letters should be of the same size.

- The thickness of the lines should be of the same width.

2. Neatness in Blackboard work

- The words and sentences written should be parallel to the base of the blackboard.

- There should be adequate spacing between the lines

- There should be no over-writing.

- Only the relevant matter which is under discussion of classroom teaching should be retained one the blackboard.

3. Appropriateness of Written work on the Blackboard

- There should be continuity in the points being presented on the blackboard.

- The points written on the blackboard should be brief and simple.

- Only the important points/words should be underlined to draw the pupils attention

- Colour chalks should be used suitably.

- Diagrams/illustrations should be developed along with the lesson.

- The diagrams should be simple, large, clear and appropriate in size. There should be no unnecessary details in the diagrams/ illustrations.

SKILL OF ACHIEVING CLOSURE

When a teacher starts to teach a lesson, the teacher tries to arouse interest and to draw the attention of the pupils while introducing the lesson. The teacher also tries to prepare them to receive the new knowledge through the lesson to be introduced

Similarly after completing the teaching, teacher wants to know whether the objectives have been achieved and also wants to know whether the pupils have learnt what they are intended to learn. Teacher should also know whether the pupils can relate the new learning with the previous learning and whether they can apply their learning to the new situation

Teacher knows about these while *achieving closure* to the lesson which are presented to the pupils. It requires a skill on the part of the teacher. *Achieving Closure* is similar to the stage of *recapitulation* in the Herbatian steps. It is a process of associating new knowledge with the knowledge they have already acquired, applying new knowledge in various situations.

The main components of the skill of achieving closure are

- Summation of the major points by the teacher or pupils
- Providing opportunities for the pupils to apply the new knowledge to various new situations
- Linking the pupils' new knowledge gained during the lesson with their previous and future knowledge.
- Creating a sense of accomplishment among pupils.

Example

After presenting the lesson on ***Compound leaves and their types*** the teacher achieves closure to the lesson as follows

T : Today we have learnt about the compound leaves and their types Let us recollect their meaning and their relationship.

T : Define a compound leaf

S_5 : A Compound leaf is a leaf which has incisions deep down to the midrib or petiole so that the leaf is broken up into a number of segments called leaflets which are arranged on a rachis and are free from one another.

T : Good. How does a compound leaf differ from a simple leaf ? (A number of students raise their hands) O.K..... S_{20} (a non-volunteer)

S_{20} : Simple leaf is a leaf which has only one lamina and compound leaf is a leaf which bears a number of leaflets arranged on the midrib or rachis.

T : Right. What are the types of compound leaves ? . ... S_{10}

S_{10} : Compound leaves are pinnately compound or palmately compound

T : What are pinnately compound leaves ?

S_{14} : Pinnately compound leaf has a number of leaflets arranged alternately or in an opposite manner on the

midrib which is called rachis

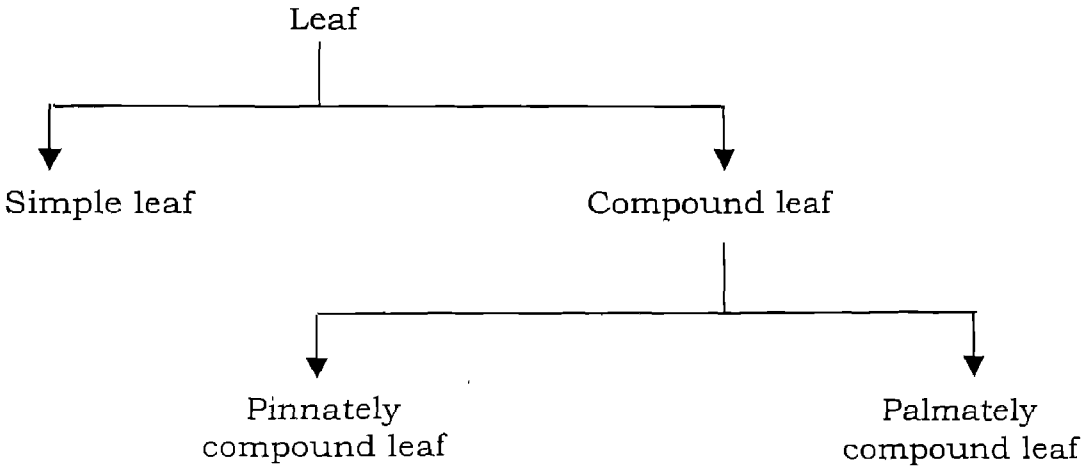
T . Yes What is palmately compound leaf ?

S_3 · Palmately compound leaf is a compound leaf in which the petiole bears terminally a number of leaflets which seem to be radiating from a common point

T · Good Give an example of a pinnately compound leaf.

S_{20} · Moringa, Tamarind plants have pinnately compound leaves.

T : Good (The teacher writes simultaneously the following flow chart/tree diagram on the blackboard representing conceptual hierarchy among the concepts)



T Well done students In the next class we will study about different kinds of pinnately compound and palmately compound leaves.

After going home all of you try to collect different types of compound leaves and try to identify and classify

of compound leaves and try to identify and classify them on the basis of the arrangement of leaflets on the midrib And bring the leaves to the class and we will discuss more about them.

STRATEGIES OF TEACHING

TEACHING OF CONCEPTS

The study of biology deals with the living and non-living beings/things. In learning about these biological things, we are concerned with what these things are When we learn what a thing is, we are learning a concept of that thing. When we teach students what a thing is, and how to identify it, we are teaching a concept of that thing By means of concepts, other concepts and other kinds of subject matter are learned. A concept is the meaning of a term used to designate the concept According to Hunt, Marin and Stone (1996), "A concept is a decision rule which, when applied to the description of an object, specifies whether or not a name can be applied "

Thus a student who knows definition of a '*stem*' as *the part of a plant which has nodes and internodes bearing branches, leaves, flowers and fruits*, has a rule that can be used to say whether the given part of a plant is said to be a stem.

Moves in teaching a concept.

Some concepts are taught, for others the term designating the concepts are used.

For example a teacher who has deliberately taught a concept of a '*simple tissue*' might not teach a concept of '*complex tissue*' but would simply use the term.

1 ***Defining*** Definitional move can be used in biology to teach the concept

Definitions are often written in the following form

----------1 is a ---------- 2 which ----------3

The first space is filled by the term being defined, the second space is filled by a term denoting a super set in which the set of objects denoted by the term defined are included, and third space is filled by one or more conditions that differentiate the set of objects denoted by the term defined from all the other subjects of the superset.

2 *Stating a Sufficient Condition or Sufficient Condition Move*

It is the form in which a characteristic or a property of an object is stated that identifies it as a sufficient condition. The logic of the move of sufficient condition enables a student to give examples of objects denoted by a concept, assuming such an example exists

If a tissue has heterogeneous groups of cells, it is a complex tissue. This statement of sufficient condition clarifies that *having heterogeneous group of cells in a tissue makes the tissue a complex tissue.*

3 *Giving one or more examples*

Examples are objects denoted by the concept i.e., members of the set determined by the concept Examples clarify concepts because they are definite, specific and if well chosen, familiar Teachers frequently elicit examples of concepts from students to decide whether the students have acquired the concepts Examples can't be given for every concept.

4 *Giving an Example Accompanied by a Reason why it is an Example*

Accompanying an example with a reason that it is an example is an effective move because the reason is a sufficient condition

This move is helpful to slow learners, because the logical connection is made explicit by supplying a reason

5 *Comparing and Contrasting Objects Denoted by the Concepts*

By comparing objects of the concept being taught with objects with which students are familiar, a bond of association can be established between familiar and less familiar.

While teaching a concept of *Complex tissue*, the teacher may compare it with a *simple tissue.* Comparison points out similarities. But since objects compared are not identical, a contrast identifies some of the differences, if not all If a teacher has taught a concept of *simple tissue* and then teaches a concept of *complex tissue*, the next step may be to contrast these two concepts in order that the students do not miss the distinction between them.

6 *Giving a Counter Example*

A counter example is an example that disproves a false definition of a concept. Two kinds of counter examples are possible for an incorrect definition.

- Give a member (an example) of the set determined by the term defined that is not a member of the set determined by the defining expression

- Give a member (an example) of the set determined by the defining expression that is not a member of the set determined by the term defined.

Though this kind of move is effective in sustaining thinking and ultimately facilitates comprehension of the desired concept, students may feel that the teacher is embarassing them Teachers have to exercise good judgement when deciding how frequently to use counter example move.

7 *Stating a necessary condition*

A necessary condition move enables students to identify examples of objects not denoted by a concept.

Example *If a tissue consists of heterogeneous groups of cells, the tissue is a complex tissue.*

A tissue is said to be a complex tissue only if it contains heterogeneous group of cells If a tissue does not contain heterogeneous group of cells, it is not a complex tissue

8 *Stating a necessary and sufficient condition*

This move is used, if a condition by which objects can be denoted by a concept is both necessary and sufficient condition One form for this is the explicit use of the terms necessary and sufficient

It is both necessary and sufficient that a tissue contains heterogeneous group of cells for it to be a complex tissue Another form is the use of *if and only if.*

The definition in terms of necessary and sufficient condition proceeds by subsuming the set of objects to be defined from all other subjects of the superset. A sufficient condition move enables a student to identify examples and a necessary condition move enables students to identify non-examples of a concept A combination of these enables students to discriminate both examples and non-examples of a

concept An example not in the set determined by a concept is a non-example of the concept

9 *Giving Non-examples*

Like the move of giving examples, giving non-examples helps to clarify a concept. Definition of a concept followed by examples and non-examples of the concept is an effective move for a teacher

10 *Giving a non-example accompanied by a reason why it is a non-example*

This move is similar to that of giving an example together with a reason that it is an example The reason that accompanies the non-example is the failure to satisfy a necessary condition. Its logic is that of conditional reasoning.

Strategies of Teaching a Concept

A strategy is defined as a temporal sequence of moves. So, theoretically, there are thousands of strategies for teaching a concept, of which some are logically impossible. Examples of some strategies of teaching a concept are represented as follows :

1. *Definition → Example → Example with a reason → Non-example with a reason.*

2. *Example → Non-example → comparison and Contrast → Characteristic → Definition → Example with a reason → Non-example with a reason.*

In such strategies, the definition identifies the necessary and sufficient conditions, examples clarify them and reasons reinforce necessary and sufficient conditions.

Uses of Concept

1. Knowledge of a concept helps in classifying given objects into examples and non-examples of the concept

   Since we can classify, we can discriminate For example, a student who has concept of *pinnately compound leaf* can pick out *pinnately compound leaf* from other compound leaves

2 Knowledge of concepts helps in communication

   Communication breaks when people do not have the knowledge of certain concepts. A definition of a term tells us both how to use the term and also how to avoid using it.

3. Concepts help in generalisation.

4. Concepts help in discovery of new knowledge

Strategy

T : In the last class we discussed about the main types of tissues. What are they ?

S_1 : Meristematic and Permanent.

T : That is right. Tissues are broadly classified into meristematic and permanent tissues. What are meristematic tissues ?

-----1 S_2 : Meristematic tissues are tissues consisting of immature cells which have the power of cell division.

T : Good Which type of tissues are called permanent tissues ? . . . . S_6 ?

-----2 S_6 . Tissues are called permanent if they have completely lost their capacity of division

T · Right What difference do you find between meristematic and permanent tissues ?

-----3 S_{10} . Meristematic tissues consist of immature cells which are not fully differentiated where as permanent tissues consist of mature cells which are fully differentiated and are not capable of cell division.

T : Yes. Permanent tissues are tissues which do not possess the power of cell division. Which parts of the plant possess permanent tissues ?

-----4 S_1 : Usually most parts of leaves, stems and roots consist of permanent tissues.

T : Right Look at these permanent tissues (showing permanent tissues drawn on rolling board). Some of these tissues are labeled as complex tissues and others as simple. From these diagrams find out the characteristics of complex tissues which are not found in the simple tissues

-----5 S_8 · There are different groups of cells in the diagram labeled as complex

T · Yes That means there are heterogeneous groups of cells in complex tissue.

T . Observe these tissues (showing the diagrams of tissues drawn on a rolling board). Name among these

tissues drawn on a rolling board). Name among these the tissues that are complex

-----6 S_2 : Fig I (Vascular bundle), Fig 4 (Phloem in L.S.) shows complex tissues

T : Is part I in the diagram (cortex of a root) a complex tissue ?

-----7 S_{15} : No

T : Why is it not a complex tissue ?

-----8 S_{13} : Because it does not contain heterogeneous groups of cells

T : Yes. Can some one now state the meaning of complex tissue ?

S : Complex tissue is a permanent tissue which consists of heterogeneous groups of cells.

EXPOSITORY STRATEGIES OF TEACHING GENERALISATON

A strategy in which the generalization is stated or asserted early in the sequence is called an expository strategy.

The word expository is derived from '*exposition*' which means an explanation or interpretation given to clarify the meaning and implications of the generalization (the object of exposition).

An expository strategy that seems to be based on the old adage, ***Tell them what you are going to tell them, tell it to them, then tell them what you told them*** is employed.

EXPOSITORY MOVES IN TEACHING GENERALISATION

1 *Introduction Move*

A move in which the teacher sets the stage for the subsequent instruction is called introduction move.

Teacher may introduce the topic (generalization) by :

(a) Focusing the students' attention on the topic of instruction. This is often done simply by naming the topic. This move is called focus move.

(b) Stating explicitly the goal or outcomes of the subsequent study. This move is called objective move.

(c) Convincing the students that the generalization to be learned is worth learning This move is called motivation move Often the students are motivated by stating the utility of learning the generalization.

There are several ways a biology teacher can initiate a lesson and provide motivation

Some of them are as follows .

i. Stating the goals of the lesson (This provides some direction to the students for study).

ii. Stating the major points to be covered in the development of the lesson.

iii. Using an analogue. In this a teacher selects some objects or situation that is familiar to the students and that has some similarity with what the students are to learn.

iv. Using historical material.

v. Reviewing the pre-requisite knowledge.

vi. Giving reasons for studying a particular topic

vii. Presenting a problem situation

2 Assertion Move

Sometimes a teacher directs the students' attention to the statement of the generalization in a textbook.

3 Interpretation Move

Interpretation move is a move used to clarify the meaning of the generalization Teachers resort to this move when they find that not all students comprehend the generalization after it is asserted

(a) Paraphrasing

In this move, a teacher states the meaning of the generalization in different words Teachers often paraphrase in verbal form a generalization asserted initially in mathematical language

(b) Instantiation

In this move a teacher uses instances or example with which the students are familiar to clarify the meaning of the generalization.

(c) Analysis Move

When a generalization is complex, as for example, a conditional whose antecedent is a disjunction or a conjunction or a bi-conditional (if and only if) generalization, teachers analyse the generalization by talking explicitly about its components and logic or about its implications. Such moves are called analysis moves.

(d) Counter Example Move

As in the case of teaching concepts, counter example move is used to disprove a false generalization. If there exists a counter example for generalization (a member of the domain for which the generalization is false), the instance formed by using the counter example is called a counter instance.

4 Justification Move

A move used to give evidence or reason that the generalization is true is called a justification move.

A teacher can justify a generalization by giving a deductive argument.

5 Application Move

Application move is a move in which generalization is applied in learning another generalization or solving of a problem After asserting the generalization teacher applies it or make the students apply it.

Strategies of teaching Generalisation

Some strategies frequently used in teaching generalizations are

1. *Assertion move → Interpretation move → Application move*
2. *Introduction → Assertion move → Interpretation move → Justification move → Application move*

Conceptual Framework for Integration of Skills

Different instructional strategies help to transact different kinds of subject matter to develop different thinking/process skills besides learning the subject matter. Use of teaching skills facilitate enhancement of interaction between the teacher and the taught. However, use of a teaching skill in itself may not lead to learning of the subject matter or development of thinking skills Integration of appropriate teaching skills with a strategy of teaching can make teaching effective.

The following conceptual framework provides an insight into the education and training to develop competence in various teaching skills The framework helps to develop decision making ability in teaching by deciding on ***what***, ***when*** and ***how*** of teaching strategies and skills The Expository Strategy provides opportunity to plan and practice the major skills viz , *Introducing a Lesson, Explaining and Achieving Closure, and the supportive skills viz.,Questioning, Stimulus Variation, Reinforcement and Use of Blackboard.*

Conceptual Scheme for Practising Skills in relation to Subject-matter and Teaching Strategies in Science

	Skill	Kinds of Subject Matter	Strategy along with the Moves
1	Stating Instructional Objectives	Concepts/generalizations/ skills	
2	Introduction	Concepts/generalizations/ skills	Discovery and expository strategies • Stating the goals of the lesson • Stating the major points to be covered in the development of the lesson • Using an analogous situation • Using historical material • Reviewing the pre-requisite knowledge • Giving reasons for studying a particular topic • Presenting a problem situation.

3	Explaining a) Interpretive	Concepts/ generalisations/skills	Expository Strategy Concept Attainment • Reviewing the meaning of the terms • Translating from symbolic to verbal form and vice versa • Paraphrasing • Giving an analogous situation • Giving egs/non-egs with reasons • Giving necessary or sufficient conditions/ both necessary and sufficient conditions
	b) Descriptive / Narrative (including demonstration)	Processes/concepts and generalizations	Expository strategy • Sequence and structure • Demonstration of an experiment • Narrating an expt/ a process with suitable learning aids
	c) Reason giving	Concepts/generalisations	Deductive Discovery Strategy

4	Questioning	Concepts/processes/ generalisations
	a) Structuring of Classroom questions b) Delivery and Distribution of questions c) Probing questioning	• Inductive deductive strategy • Inquiry strategy • Problem solving • Concept mapping
5	Stimulus Variation	All kinds of subject matter Treated as supportive skills and practised in every teaching situation
6	Reinforcement	
7	Use of Blackboard	
8	Achieving Closure	

The following dialogue illustrates the expository strategy and the various teaching skills embedded with the strategy.

STRATEGY

(After relevant introduction to motivate the students to learn the topic photosynthesis, the teacher asserts the definition of photosynthesis as follows.)

T Photosynthesis is an anabolic process of preparing food by plants in the presence of sunlight and chlorophyll.

What is anabolism . . . S_5 ?

S_5 Anabolism is the process of synthesizing complex organic food materials from simple inorganic materials.

T : Good, What are the complex organic food materials ?

S_2 : Carbohydrates, proteins and fats

T : Yes What are the simple inorganic materials that plants require to carry out this process ?

S_{10} : Plants require carbon-dioxide and water

T : Right. Where from do the plants get these inorganic materials ?

S_1 : Plants get water from soil and carbon-dioxide from air.

T : Correct Can all plants prepare food if CO_2 and water are available ?

S_{14} : No.

T : Why ?

S_{14} : . .....

T : Which part of the plant can carry out photosynthesis ?

S_{14} : Leaves.

T : Why does this process take place only in leaves ?

S_{19} : Because they are green in colour.

T : Which is responsible for their green colour ?

S_{19} : Chlorophyll

----------1

T : Right, Plants can carry out photosynthesis in any green part because they need chlorophyll to prepare food Now define photosynthesis in your own words. ... . S_7 ?

S_7 : Photosynthesis is the process by which plants prepare complex organic food materials from carbon-dioxide and water in the presence of sunlight and chlorophyll.

----------2

T : Right Can you express the process of photosynthesis as an equation in verbal form ? . . . . S_{15} ?

S_{15} . . ..

T : What are the simple inorganic materials that plants require to synthesize organic food materials ?

Write it on the board S_{15} . . . ?

S_{15} . Caron–dioxide + water ⟶ Carbohydrate + oxygen.

T : Mention the other requirements also in the equation.

S_{15} : Carbon-dioxide + water $\xrightarrow[\text{Chlorophyll}]{\text{Sunlight}}$ Carbohydrate + Oxygen

T : Very good. Now write it in the form of a chemical equation using formulae . S_{20} ?

S_{20} : $CO_2 + H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + O_2$

---------- 3

T . You are right. And we can balance this equation as

$$6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

Give an example of a plant which cannot prepare its food material

S_9 : Mushrooms.

T : Why are they incapable of preparing food ?

S_9 : Because they lack chlorophyll

---------- 4

T : You are right So plants which have chlorophyll can only prepare food by themselves. What are the essential requirements for the plants to prepare food ? (You, pointing to S_6) ?

S_6 : Carbon-dioxide, water, sunlight and chlorophyll.

T : That's right. What would happen if a plant is not supplied with one of the essential requirements, say carbon-dioxide ?

S_4 : Plants can't synthesize their food.

---------- 5

T : S_4 says that plants cannot synthesise their food if they are not supplied with CO_2 Now let us try to verify this. What should be done to know whether a plant can prepare food or not in the absence of CO_2 ?

S_{11} : The plant should not be supplied air with CO_2

T : Good. How can we supply CO_2 – free air to a plant ?

S_{11} : . . ..

T : You have studied about some chemical substances Which chemical substance can absorb CO_2 ?

S_{11} : Potassium hydroxide (Teacher gives the name if pupils fail to answer).

T How can you conclude that plants cannot photosynthesise because of the lack of supply of CO_2 ?

S_{13} : We can test the leaves for the presence/absence of starch which is produced during photosynthesis.

T : Yes What is the test for the presence/absence of starch ?

S_{13} : ....

T : We can use iodine solution to test for the presence/absence of starch ?

What precaution should be taken in selecting a plant for this experiment ?

S_{20} : The plant which does not have starch.

T : Why ?

S_{20} : Then we can say that the absence of starch is due to the non-availability of Co_2 to the plant when all other essential requirements are provided to the plant.

T : Right. So for the experiment we should select a plant which does not have starch in it. How can a plant be

made starch-free ?

S_1 . It should be made to utilize all the starch.

T . What could be done to make the plant utilize all the starch ?

S_3 . Light should not be provided to it so that it cannot photosynthesize and it utilizes the available reserve food (starch).

---------- 6

T : Yes. How will you make the plants utilize the available starch ?

S_3 : Plants can be kept in dark.

T . Right. For the experiment, we can select a plant which is kept in dark for few days Here is a labeled diagram showing the experimental set-up to show that plants do not synthesize food in the absence of CO_2. How would you proceed to perform the experiment ? ..... S_{12} ?

S_{12} . Take some KOH pellets in a small petridish and keep it under one bell jar and place a well watered potted plant 'A' under the bell jar. Insert a thistle funnel through one holed rubber cork fitted to the mouth of the bell jar.

T : Good. Now what should be done ? . ... . S_{19} ?

S_{19} . Keep cotton in the mouth of the funnel and place some KOH pellets on that to supply CO_2 – free air to the plant.

In the same way arrange another set-up but without any KOH pellets to supply air with CO_2 to the plant 'B'.

(Teacher corrects the pupils' mistakes, if any, while describing the experiment and clarifies the doubts)

---------- 7

T . Very good. Now set-up the experiment and expose it to the sunlight for 2-3 hours

(Pupils conduct the experiment and verify the leaves of plants A and B for the presence/absence of starch by testing the leaves with iodine solution)

T : What do you observe in the leaves of plant 'A' and 'B' when tested with iodine solution ?

S_4 : The leaf of plant A remained colourless and that of B turned blue.

T : What do you infer from this test ?

S_4 : Starch is present in the leaf of plant 'B' whereas it is absent in the leaf of plant 'A'

T : Right. What is this difference due to ?

S_6 : The absence of starch in plant 'A' is because of the lack of supply of CO_2 which is the only difference in the experimental conditions between the two plants A and B.

T : What do you conclude from this experiment ?

S_{10} : From this experiment, we can conclude that CO_2 is necessary for preparing food materials along with other essential requirements.

APPENDICES

APPENDIX - A **PROGRAMME SCHEDULE**

Training Programme on Skills And Strategies of Teaching Science at Secondary Stage

Date / Day	09.00AM to 10.00 AM	10 00 AM to 11.30 AM	11.45 AM to 01.00 PM	01.00 PM to 02.00 PM	02.00 PM to 03.00 PM	03.00 PM to 04.00 PM	04.10 PM to 05.30 PM
24 03 05 Thursday	Registration	Introductory Session	*Teaching Skills* - Nature Types and Micro-teaching approach to their learning. Prof. GNPS, Dr YN	**L**	Presentation and discussion on *'Skill of Introducing a Lesson'* Dr PD, Dr YN	Symbolic Models on *'Skill of Introducing a lesson'* - Analysis and Discussion Dr BKP, Dr TJV Prof KD	Group work on preparation of symbolic models and discussion Biology / Chemistry / Physics
25 03 05 Friday	Presentation and discussion on *'Skill of Explaining'* Prof KD, Dr PD, Dr YN	Symbolic models on *'Skill of Explaining'* Chemistry / Physics / Biology Dr PD, Dr TJV, Dr YN	Exercise and Discussion on kinds of explanations required for different kinds of knowledge. Dr TJV, Dr YN	**U** **N** **C**	Presentation and Discussion on Inquiry/Discovery Strategies Dr MKS, Prof KD	Presentation and Discussion on *'Skill of Questioning'* Dr SS Dr YN	Symbolic Models on *'Skill of Questioning'* - Analysis and Discussion Dr TJV, Dr YN
26 03 05 Saturday	Group Work on preparation of symbolic models and discussion. Physics/Chemistry/Biology			**H**	An Integrated Approach to Develop Competence in Teaching Skills Prof K D		Group work on preparation of Symbolic model based on integrated approach Physics/Chemistry/Biology
27 03.05 Sunday	Presentation and Discussion on *'Skill of Probing Questioning'* Dr PD Dr YN	Symbolic models on *'Skill of Probing Questioning'* Chemistry / Physics / Biology Prof KD, Dr TJV, Dr YN	Presentation and Discussion on *'Concept Mapping Strategy'* Dr TJV		Group Work on preparation of symbolic models and Practising the Skills		Visual Model on Integrated Approach – Analysis and Discussion Prof KD
28 03 05 Monday	Presentation of prepared models by participants and discussion Physics/Chemistry/Biology Dr PD, Dr TJV, Dr YN				Finalisation of the prepared symbolic models	Programme Evaluation Dr YN	Wrap-up Session and Disbursement of TA/DA

Appendix – B

Model plans prepared by participants are given here, which may be used for discriminant analysis to identify appropriate and inappropriate use of skills/component skills to develop decision-making ability in teaching.

APPENDIX - B

Skill of Introducing a Lesson

Class - X Physics

Topic : Reflection of light by mirrors

You all know that nobody can see anything without light. So, light is a factor which enables us to see things. You already know that image is formed by the reflection of light.

T : What is reflection ?

S_1 . The phenomenon by which light travelling from a medium strikes the surface of a second medium and returns back to the first medium is called reflection.

T : Yes, you are right. You have learnt about laws of reflection. State a law of reflection. (Pause) .. ..You. . .. S_5 ?

S_5 : The incident ray, reflected ray and normal drawn at the point of incidence lie on the same plane.

T : What is the relation between angle of incidence and angle reflection of light ? . . . . S_3

S_3 The angle of incidence (i) is equal to the angle of reflection (r)

T . Can you name a thing you use to see your image ?

S6 . Mirror

---------***Reviewing the prerequisite knowledge***

T : Suppose you are standing in front of a transparent glass. You cannot see your clear image. But when you are standing in front of a mirror, you can see your image. What is the reason behind it ?

---------***Presenting a problem situation***

T . Today we will discuss the reflection by mirrors – both by plane mirror and spherical mirrors and we will study the nature of the images formed.

---------***Stating the major points to be covered in the development of the lesson***

Class - IX

Topic : Our Natural Resources

Teacher writes the topic '*Our Natural Resources*' on the Black board.

History of human civilisation like the history of the earth, evolution of life, can be divided into different epochs on the basis of major sources of power and fuel. Basic needs of life, from the Indus Valley civilisation to modern era, are fulfilled by materials present in the nature. These natural resources are widely used in agriculture, transport and industry The metals like iron, aluminium, copper, silver and gold are among the important natural resources to the mankind. This history may be the basis of the study of Natural resources.

---------***Using Historical Material***

Today, in the era of technological advancement, the natural resources are used in innumerable ways. With increasing population and technological developments the natural resources are being over exploited. Today we will discuss how we conserve our nature and

Subject : Chemistry

Topic : Acids And Bases

In previous classes, you have studied about the properties of acids and bases. What is the cation produced from an acid in an aqueous solution ?

S : Hydronium ion

T : Yes What is its formula ?

S : H_3O

---------***Reviewing the prerequisite knowledge***

Today we will discuss the *definition of an acid, classification and properties of acids*

---------***Stating the major points to be covered in the development of the lesson***

T . A man has eaten large amount of food and consequently, acid is formed and he may fall sick. What do you suggest to him to get immediate relief instead of calling a doctor ?

---------***Presenting a problem situation***

This body of knowledge that we are going to discuss has a wider application in measuring pH or pOH of the solution and titration.

---------***Giving reasons for studying a particular topic***

T : Arhenious defines acids as a producer, Bronsted and Lowery defines acids as a proton donor, But how does Lewis define acid ?

---------***Historical material***

T · Acid contains hydrogen atom, what atom or radical does a base contain ? Acid produces ion in an aqueous solution.

What ion is produced from a base in an aqueous solution ?

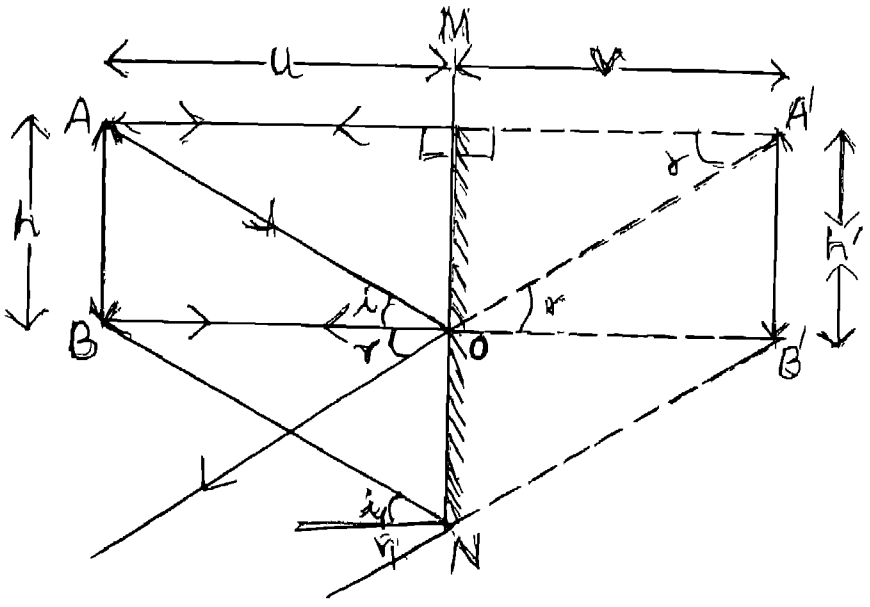
Skill of Explaining

Class – X Physics

Topic : Reflection of light by plane mirrors

(After introducing the lesson, to motivate the students to learn the topic *Reflection of light by plant mirror*, teacher shows them a diagram of reflection of light by plane mirror drawn on a chart)

T : Teacher shows the chart having a diagram of reflection of light by plane mirror . All of you observe the diagram.



AB is the extended object of height h. It is placed at a perpendicular distance 'u' on the left of a plane mirror MN and we observe that an image is formed by the mirror

Which are the incident rays from point A ?

S1 : AO and AC are the incident rays from point A

T : Good, which are the reflected rays ?

S3 : CA and OD are the reflected rays

T : Yes, what is the nature of the two reflected rays ?

S_5 : The two reflected rays are divergent in nature

T : Good. So they cannot actually meet in front of the mirror Then, if we extend these rays backwards, what happens ?

S_7 : They meet at a point A'.

T : Yes, what is the relation between A and A' ?

S_{10} : A' is the image of A

T : Good. Similarly, B' is the image of point B. From A to B there are several points. Each and every point will have an image between A' and B'.

What is the image of AB ? (Pointing to S_{15})

S_{15} : A'B' is the image of AB.

---------***Descriptive (narrating an experiment)***

T : Good. What type of image is this ?

S_{22} : No response.

T : This type of image is called virtual image. This image A'B' is formed at a distance 'V' from the mirror. Why is it virtual image ?..... S_2

S_2 : As this image cannot be formed on a screen, it is called virtual image.

---------***Reason giving***

T · Now consider the two triangles △ACO and △A'CO in the figure. What is the relation between these triangles ?

S6 : They are congruent.

T · Good. Then what is the relationship between AC and A'C ?

S4 . They are equal i e., u = v,

---------***Interpretive (translating from verbal to symbolic form)***

T : Yes. Then the object distance and image distance are equal. Now consider another two triangles △ABO and △A'B'O. They are also congruent. Then what do you observe regarding AB and A'B' ?

S_{17} : A'B' is equal to AB.

T : Yes. Then what do you say about the size of the image ?

S_{20} . Image is of the same size as the object.

T · Good. Imagine yourself in front of a plane mirror. If you raise your right hand what do you find in case of your image in the mirror ?

S_{30} : In case of image, left hand will be raised.

T · Good So the image formed by plane mirror is laterally inverted. Now tell the nature of image formed by a plane mirror . . . S19

---------***Reason giving***

S19 : The image formed by a plane mirror is virtual and erect It is of the same size as of object. The image is formed as far behind the mirror as the object is in front of it. And image is inverted sideways.

Chemistry

Topic : Acids and Bases

T : Acid is a compound containing one or more hydrogen atoms in which hydrogen is partially or totally replaceable by metal or metal like radicals and which reacts with alkali to form salt and H_2O.

Give an example of an acid ?

S . Hydrochloric acid (HCl)

T : Why is it an acid ?

S · Because it contains one hydrogen atom, which is replaceable by metal and it reacts with alkali to form salt and water

T : Give an example of a reaction with alkali.

S . $HCl + NaoH \rightarrow NaCl + H_2O$

---------***Interpretive : Reviewing the meaning of the terms.***

T : Does pure HCl act as an acid ?

S : No.

T : Why ?

S : Because, it is covalent, it can't produce H+ ion in solution

T : When does HCl act as an acid ?

S : When HCl is mixed with water, it can act as an acid.

T : How do you define an acid with reference to ionization?

S : Acids are compounds which produce H+ ion in aqueous solution.

---------***Interpretive (para phrasing)***

T : Give an example of hydrogen containing substance which is not an acid.

S : Methane

T : Why is methane not an acid ?

S : It contains four hydrogen atoms, but it can't produce H + ion in an aqueous solution.

---------***Interpretive (giving example, and examples with reasons)***

T : Teacher gives lemon juice and vinegar to some students to taste. What is the taste of these compounds ?

S : Sour

T : What are the compounds commonly called ?

S : Acids

T : What do you conclude from this ?

S : Acid are Sour in taste.

T . Teacher pours three different acids in three different test tubes and adds 2-3 drops of phenolphthalein in each test tube ? What are the colours developed in each test tube?

S · Colourless

T : What conclusion can be drawn from this experiment ?

S : Colour of phenolphthalein in contact with acid remains colourless.

---------***Reason-giving***

Skill of Probing Questioning

Class : X

Topic : Transportation

T Transportation is a process in which a substance absorbed or synthesized in one part moves to the other parts of the body.

T : What are the substances that are absorbed in plants ?

S : Water and Minerals.

T . New tell me what is synthesized in plants ?

S · Glucose

T : Which part of the plant is responsible for absorption of water ?

S : Root

T · To which parts of the plant water is transported ?

S · Leave, Flowers.

T : What will happen if water falls to each the tissues of the leaves ?

S · Plants fail to synthesize their food They may dry up and die.

Refocusing T : How many types of conducting tissues are there ?

S : Two types.

T Name them.

S : Xylem and Phloem.

Refocusing T : Which type of conducting tissue is responsible for water transport ?

S : Xylem

T . Teacher draws the diagram and explains. Water along with minerals is absorbed by root hairs which are in contact with the film of water in between the soil particles. After absorption by root hairs water enters roof cortex and moves through endodermis to root xylem.

T · To which part of the plant tissue system water moves from root xylem ?

S : Stem Xylem

T : From the stem xylem water is transported to the mesoplyll tissue of the leaves.

T · Against which type of force, the water column moves ?

S : Against the force of gravity.

Increasing Critical Awareness T : How does transport of water to the upper parts of the plant take place ?

S : .. ..

Prompting T : Let us take an example. What happens when we suck fruit juice with the help of a straw ?

S . The vacuum of the straw is filled by the fruit juice and it enters the mouth

T : There is a difference of pressure within and outside the straw. The pressure outside the straw is more than inside, because of which fruit juice enters the straw when we suck

Seeking further information T : What is the similarity between the movement of fruit juice in the straw and that of water in the stem xylem ?

S : In both cases upward movement takes place against the force of gravity

T : Good.

T . What will happen if transpiration takes place continuously ?

S · Scarcity of water occurs in some of the cells of mesophyll tissue.

T : What do the cells try to do to overcome this ?

S . The cells try to draw water from the adjacent cells and from the cells of the stem xylem.

T : A pull is created due to transpiration. What is it called ?

S . Transpiration pull.

T : In addition to the *transpiration pull* what are the other factors responsible for the transportation of water ?

S : ... .

T : In there any difference of pressure created ?

S : Yes.

T . The atmospheric pressure is more than the pressure inside the cells. So due to this difference in pressure water moves from the adjacent cells as well as from the stem xylem. (Teacher draws a diagram to explain)

T : Because of these two factors the movement of water takes place. But after reaching upto a certain height the column of water may fall

Refocusing Is there any other force of attraction responsible for the maintenance of the continuous column of water ?

S . .. .

Prompting T When there is a force of attraction between two different types of molecules, What is it called ?

S : ... .

T How does the adhesive tape help for sticking ?

S A force is developed between the gum of the tape and the material to which it is stuck.

T . What is this force called ?

S : Adhesive force.

T So force of adhesion develops between the cells of the xylem and water molecules.

T : There is force of attraction between the water molecules also. What is it called ?

S . Cohesive force.

T : Because of the transpiration pull, pressure difference, adhesive and cohesive forces, transportation of water along with minerals, takes place.

APPENDIX - C

List of Participants

1. Dr. Debi Prasad Nag Chowdhury
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5. Sri Pratap Kumar Jana
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Chandernagore, Hooghly (Dt.)
Pin – 712 138 West Bengal

6. Ms. Paushalee Datta
Union Christian Training College,
Berhampur (P.O.), Murshidabad (Dt)
Pin – 742 101 West Bengal

7. Mrs. Krishna Nag Chowdhury
(Volunteer Participant)

List of Resource Persons

External Resource Persons

1. Dr S. Samal
2 Dr P. Das

Internal Resource Persons

1. Prof. K. Dorasami
2. Prof G.N.P Srivastava
3 Dr T.J. Vidyapati
4. Dr. M.K. Satpathy
5. Dr. B.K. Parida